

SUBJECT: Preliminary Crew-Time Estimates
for AAP-1/AAP-2 Experiments -
Case 610

DATE: December 2, 1969

FROM: B. H. Crane

ABSTRACT

Tentative estimates of crew time are available for twenty-seven of the thirty-five AAP-1/AAP-2 experiments that require inflight participation by the crew. Based on this data, three of the twenty-seven experiments account for more than 50% of the total man-hours:

M071 - Mineral Balance

M171 - Metabolic Activity, and

M508 - EVA Hardware Evaluation.

It is recommended that major uncertainties in these relatively large crew-time estimates be resolved early in the development of the experiments. Crew-time requirements should also be evaluated in the context of other experiment requirements and mission constraints that affect experiment scheduling.

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MEMORANDUM FOR FILE

Only tentative estimates of inflight crew time required by AAP experiments are presently available for use in mission planning. Substantial changes may occur in some of these estimates as uncertainties in experiment requirements, hardware designs, and operating procedures are resolved. Initial estimates of times for specific tasks will also be updated as a by-product of experiment test and training exercises in which the flight crew participates.

Thirty-five of the forty-four experiments currently assigned to the AAP-1/AAP-2 mission require inflight participation by the crew. Tentative inflight crew-time estimates are available for twenty-seven of these experiments. A complete list of the experiments in each of these categories is given in Table I.

The twenty-seven experiments for which crew time estimates are available are shown in Table II, ranked in order of the total man-hours required on AAP-1/AAP-2. Time estimates for these experiments are based primarily on task analysis and, in some cases, a preliminary walk-through of the experiment. Notes appended to the table explain the manner in which it was constructed.

Based on this data, the first twelve experiments in Table II require more than ninety percent of the total crew time for all experiments in the table. M071 - Mineral Balance, M508 - EVA Hardware Evaluation, and M171 - Metabolic Activity alone require more than half of the total crew time.


Crew time actually required for M071 may be considerably greater than the 75.3 man-hours shown. A major source of uncertainty in estimating this time is lack of resolution in requirements for processing and preserving urine samples. As a minimum, steps must be taken to either dry the samples or reduce their volume for freezing, in addition to measuring their original mass and logging the results. Five minutes per sample is included in Table II for these activities, which would cover only the required mass measurements according to the Experiment Requirements Document (ERD) for M074 - Specimen Mass Measurement. The discrepancy is even greater if time is charged to M071 for operation of the

Habitability Support System (HSS) to obtain the samples. Although each of these times is small, the effect of many repetitions (more than 150 per man) can have a significant impact on the total crew time required over the mission.

Each of the two subjects for M508, EVA Hardware Evaluation, performs eighteen trials of a basic task sequence under various conditions of restraint. There are six trials per subject in shirtsleeves, six in the A7LB space suit, and six in a constant-volume space suit. Consideration is presently being given to whether the objectives of M508 can be achieved with fewer trials.* Two-thirds of the experiment trials for M171, Metabolic Activity, also require suited and unsuited performance of basic tasks for the purpose of obtaining precise metabolic measurements. These trials result in more than 100 man-hours of crew time over the two experiments.

The sizable crew-time requirements of M071, M508, and M171 should be carefully evaluated. Major uncertainties in the relatively large crew time requirements identified in Table II should be resolved early in the development of the experiments. Underestimates could have a significant impact on the crew time available to meet all experiment objectives assigned to the AAP-1/AAP-2 mission. Crew-time requirements must also be evaluated in the context of other experiment requirements and mission constraints that affect experiment scheduling.

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*G. Duncan, Trip Report: Experiment M508 PRR Pre-Board Meeting, MSC, July 10, 1969 - Case 620, Memorandum for File, July 25, 1969.

TABLE I

EXPERIMENTS CURRENTLY ASSIGNED TO AAP-1/AAP-2

1. Inflight experiments for which preliminary crew-time estimates are available (see Table II).

D008	Radiation in Spacecraft
D021	Expandable Airlock Technology
D024	Thermal Control Coatings
M071	Mineral Balance
M074	Specimen Mass Measurement
M092	In-Flight Lower Body Negative Pressure (LBNP)
M093	Vectorcardiogram
M131	Human Vestibular Function
M151	Time and Motion Study
M171	Metabolic Activity
M172	Body Mass Measurement
M507	Gravity Substitute Workbench
M508	EVA Hardware Evaluation
M509	Astronaut Maneuvering Equipment
M512	Materials Processing in Space
S009	Nuclear Emulsion
S015	Zero-G Single Human Cells
S019	UV Stellar Astronomy
S020	UV/X-Ray Solar Photography
S073	Gegenschein/Zodiacal Light
S101	Multiband Photography
S149	Particle Collection
T003	In-Flight Aerosol Analysis
T013	Crew Vehicle Disturbance
T020	Foot-Controlled Maneuvering Unit
T025	Coronagraph Contamination Measurement
T027	ATM Contamination Measurement

2. Inflight experiments for which preliminary crew-time estimates are not available.

M402	Orbital Workshop
M487	Habitability/Crew Quarters
S052	White Light Coronagraph
S054	X-Ray Spectrographic Telescope
S055	UV Spectrometers
S056	Dual X-Ray Telescopes
S063	UV Airglow Horizon Photography
S082	UV Spectrograph/Heliograph

Table I (contd.)

3. Experiments that do not require inflight crew time.

M072	Bone Densitometry*
M073	Bioassay of Body Fluids
	<u>Note:</u> In-flight operations are covered by M071.
M091	Lower Body Negative Pressure (LBNP)*
M111	Cytogenic Studies of Blood*
M112	Man's Immunity - In Vitro Aspects*
M113	Blood Volume and Red Cell Life Span*
M114	Red Blood Cell Metabolism*
S150	Galactic X-Ray Mapping
T018	Precision Optical Tracking

*Pre- and Post-flight only.

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TABLE II

PRELIMINARY CREW TIME ESTIMATES FOR AAP-1/AAP-2 EXPERIMENTS

A. Crew Time Summary

	<u>Experiment</u> <u>Number</u>	<u>Data Source</u> (See note below)	<u>Crew Time</u> (Man-hrs.)	<u>Cumulative Time</u> <u>and % of Total</u>	<u>Notes</u> <u>in C</u>
1.	M071	ERD, May 1969	75.3		1
2.	M508	EIRD, 6/30/69	71.3		2
3.	M171	EIRD, 6/25/69	65.3	211.9 = 52.3%	3
4.	M092	ERD, Oct. 1969	37.3		
5.	M131	EIRD, 6/30/69	31.5		
6.	M509	EIRD, 6/30/69	29.3		
7.	M093	ERD, 3/28/69	24.3		
8.	S019	ERD, Aug. 1969	9.0		4
9.	T020	EIRD, 4/23/69	8.7		
10./11.	T027/S073	EIRD, 6/17/69	8.1		5
12.	M512	EIRD, 6/4/69	7.9	368.0 = 90.9%	
13.	T003	EIRD, 6/30/69	5.7		
14.	M151	PRFP, 4/26/69	5.5		6
15.	T025	ERD, Aug. 1969	4.9		
16.	S020	EIRD, 4/10/69	4.5		7
17.	M507	EIRD, 6/30/69	3.3		
18.	S101	EIRD, 5/22/69	2.8		8
19.	T013	EIRD, 6/30/69	2.2		9
20.	D008	ERD, Dec. 1968	2.2		
21.	S149	EIRD, 6/30/69	1.8	400.9 = 99.0%	
22.	D021	EIRD, 6/30/69	1.0		
23.	M074	ERD, June 1969	.9		1
24.	M172	ERD, Sept. 1969	.8		1
25.	S009	EIRD, 6/30/69	.7		
26.	S015	PRFP, 4/26/69	.5		10
27.	D024	EIRD, 6/30/69	.1	404.9 = 100%	

NOTE: Sources are preliminary and do not carry program approval.
ERD's for all experiments are to be developed into the
approved sources of experiment requirements.

ERD - Experiment Requirements Document, dated as
shown.

EIRD - Experiment Integration Requirements Document,
dated as shown.

PRFP - Preliminary Reference Flight Plan, Martin
Marietta Corporation, 4/26/69.

Table II (contd.)

B. General Notes

1. Total crew-time requirements for each experiment are obtained by summing the crew times required for various subtasks identified in the referenced source. The component times represent the product of an elapsed time for each subtask, the number of crewmen required to perform it, and the number of performances on AAP-1/AAP-2.
2. It is assumed that a fixed number of crewmen are committed for the full duration of each subtask. The subtasks used in preparing Table II were selected so as to require only short wait times for equipment operation or coordination with another astronaut. Some calculations in the referenced sources include only active crew time, however, in estimating total crew-time requirements.
3. Times for transfer of equipment from the multiple docking adapter (MDA) to the orbital workshop (OWS) are omitted in Table II, whenever the available information is sufficiently detailed in the referenced sources to identify these times as a separate entity. These transfer times were formerly needed for the "wet" workshop configuration. Short set-up times may be needed in the "dry" workshop to replace the transfer times omitted here.
4. The crew-time estimates shown for each experiment include all operations, such as suit donning, that are identified in the referenced sources as essential to completing the experiment in a prescribed manner. Additional time may be needed, however, for transitions that depend upon how the experiment is scheduled relative to other tasks, such as crew movement or changes of location for the 16 mm cameras and lights.
5. Some tasks are not included in the referenced sources because they have not yet been identified or sufficiently well defined, such as the operations needed to satisfy some experiment pointing requirements.

Table II (contd.)

C. Notes on Specific Experiments

1. M071/M074/M172: The total crew time shown for M071 is based on twenty-seven experiment days. Time for mass measurements of M071 samples and time for body mass measurements are assumed to be covered by M071. These times are not included with M074 and M172, respectively, although the estimates given for M071 appear to be inadequate to cover all required tasks.
2. M508: Six man-hours is allotted in the referenced source for initial deployment and final stowing of the experiment. It is not clear from this task analysis how much of the 90 min/man for each of these tasks can be omitted in the "dry" workshop.
3. M171: Crew-time estimates for the three modes of M171 are 18.0 man-hours for Mode A - Resting Metabolic Rate and Bicycle Ergometry, 18.8 man-hours for Mode B - Unsuiting Maintenance and Constant Work Task, and 28.5 man-hours for Mode C - Suited Maintenance and Constant Work Task.
4. S019: The assumption is made that each of the twenty-five starfields would require 18 minutes (approximately half a night pass) for six exposures, including operation of the mirror system. One-half hour is allowed, arbitrarily, for stowing the experiment twice.
5. T027/S073: The crew-time estimate shown for the two experiments is based on a combined timeline in the referenced source. If T027 is performed in a solar-oriented scientific airlock on the "dry" workshop, however, the T027 photometer could not be pointed in a direction away from the sun during intermediate dark-side passes to perform S073. This problem is unresolved.

Table II (contd.)

6. M151: Crew time charged to M151 includes only supporting activities such as camera mounting, film changes, and camera settings that are integrated into the timelines of other experiments to be photographed. The estimate shown is only a guess contained in the referenced source. This estimate may be much too small, based on individual task times given in the M151 EIRD of 6/30/69. To make a revised estimate, however, one would need a current list of experiment tasks to be photographed and some assumptions as to how they are to be scheduled.
7. S020: Minimum time required for one man to operate the experiment is given in the ERD as four hours. One-half hour is added, arbitrarily, for set-up and stowing.
8. S101: Recent information indicates that crew time required to perform S101 will be three to four times the estimate shown, due primarily to an increased number of required exposures. If maneuvers are required to orient the spacecraft prior to site photography, they could also significantly increase astronaut time requirements.
9. T013: The assumption is made that three crewmen are committed to T013 during data-gathering phases, since the third man is not available for other tasks while he is required to remain motionless.
10. S015: Only the two fix cycles on the fourth and tenth mission days are included in the estimate shown, using the crew times in the referenced source for these tasks.

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